Quantum Nodes: Quantum Computing Applied to 3D Modeling

Laurine Capdeville*
Théo Gautier*
Luc Pinguet*
Félix Olart*
Éloïse Tassin*
capdevillelaurine@gmail.com
contact@theogautier.fr
lucpinguet91@gmail.com
felix.olart56@gmail.com
elo.tassin@gmail.com
Université Gustave Eiffel
France

Alain Lioret
alainlioret@gmail.com
Université Paris VIII
Paris, France

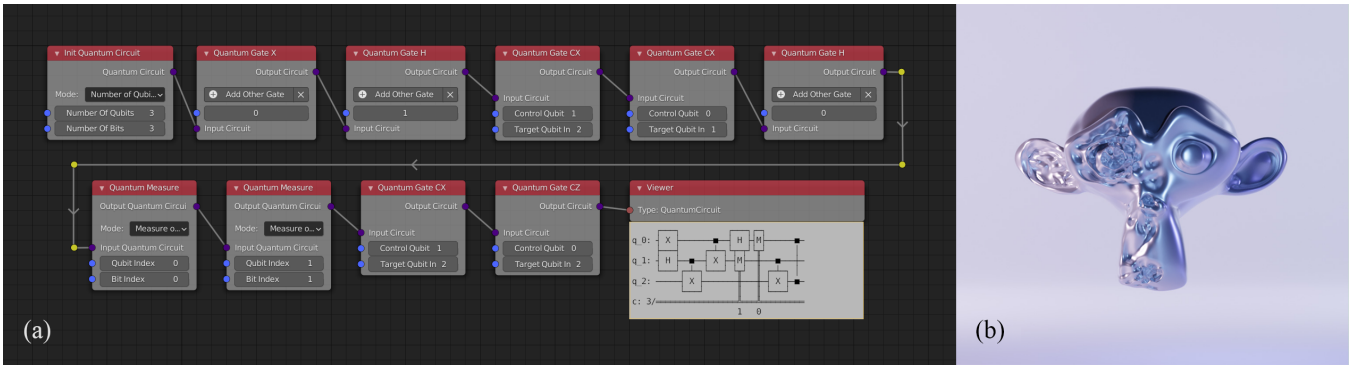

Figure 1: (a) A quantum circuit in Quantum Nodes. (b) Artistic creation made with multiple node trees.

ABSTRACT

Quantum Nodes is a Blender add-on that introduces the integration of quantum algorithms into the 3D creation process. Our work focuses on allowing users to experiment both new forms of creation and approaching the concepts of quantum computing through 3D creation.

CCS CONCEPTS

• **Human-centered computing** → Visualization; • **Applied computing** → **Arts and humanities**; *Physics*; • **Computing methodologies** → *Animation*; *Shape modeling*.

ACM Reference Format:
Laurine Capdeville, Théo Gautier, Luc Pinguet, Félix Olart, Éloïse Tassin, and Alain Lioret. 2021. Quantum Nodes: Quantum Computing Applied to 3D Modeling. In *Special Interest Group on Computer Graphics and Interactive Techniques Conference Posters (SIGGRAPH '21 Posters), August 09-13, 2021.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3450618.3469155

*The five authors contributed equally to this research.

SIGGRAPH '21 Posters, August 09-13, 2021, Virtual Event, USA

ACM ISBN 978-1-4503-8371-4/21/08.
https://doi.org/10.1145/3450618.3469155

1 INTRODUCTION

Quantum computing is the focus of many discussions and large companies such as Google (Cirq), IBM (Qiskit), Microsoft (Quantum Development Kit) or Atos (myQLM) have chosen to further invest in the field. Indeed, it could make it possible to solve rapidly complex numerical problems that are out of reach for classical computers. However quantum computing is not only a promise of performance, it also arouses a lot of curiosity, and expands the field of possibilities including for artists.

The collaboration between art and quantum mechanics is particularly interesting: on the one hand, quantum mechanics gives artists access to new approaches of reality and on the other hand, artists provide original ways to vulgarize or apply the mechanisms of quantum mechanics. For instance, the artist Libby Heaney explored complexity in the postdigital by referencing the principles of quantum superposition, quantum entanglement and quantum measurement through her work [Heaney 2019].

Unfortunately, there are few, if not any, tools available today that allow artists to easily use quantum computing concepts. Our work focuses on allowing users to experiment both new forms of creation and approaching the concepts of quantum computing through art.

The add-on we have developed is an introduction to the integration of quantum algorithms into the 3D creation process. It makes it possible to experiment with some of the main quantum phenomena, namely quantum entanglement, quantum teleportation and state superposition. As a result, we allow 3D artists to have access to a new way of creating. Thanks to its visualization tools, Quantum Nodes also enables scientists to approach the comprehension of these concepts through 3D creation.

2 OUR APPROACH

We propose an integration of quantum algorithms in the 3D creation process. Our objective is to enable quantum circuits manipulation in the 3D software Blender while integrating this tool into its already existing 3D pipeline.

Our tool is developed in Animation Nodes, a node-based visual scripting system designed for motion graphics in the 3D software Blender [Tiss 2017]. It is within this add-on that we have integrated nodes related to quantum computing using the Qiskit python library.

A quantum circuit can be represented as a data stream (input - computation - output), just like nodal programming in 3D software, which makes its implementation as nodes natural. In addition, this solution is in line with the "everything is node" trend that is currently taking place in the 3D creation industry. The Qiskit functionalities we integrated into Animation Nodes are, among others, quantum gates, quantum circuit initializers, output data visualization tools or IBMQ providers. Thanks to these new nodes, it is possible to manipulate some of the most emblematic gates of quantum computing in a 3D software such as the Hadamard gate which models the state superposition and the CX gate for quantum entanglement.

To connect the existing nodes to the ones we created, different approaches were possible. We chose to implement the solution found by James Wootton in his QuantumBlur algorithm [Wootton 2020] It makes it possible to translate a dataset like the vertices of a mesh, vectors, matrices, etc into a quantum circuit. After applying quantum logic gates to the quantum circuit, the reverse process is applied to translate the outputs of the quantum algorithm into "real" data i.e. the vertices of a mesh, vectors, matrices or other data depending on the input. However, it is important to remember that James Wootton's algorithm is only one approach among others. The strength of our tool is that it is fully programmable, it is therefore possible to create alternate solutions, potentially more relevant.

In addition to being a new way of creation for artists, our tool offers features that may be of interest to scientists. Indeed, it is possible, thanks to Qiskit, to perform the calculations of the quantum circuits on simulators. We have also integrated visualization tools widely used in the field of quantum computing directly in the 3D environment of Blender, like the Bloch sphere (see Fig. 2) and histograms.

Finally, we added an additional node that makes possible the manipulation of a 2D simulation of the Schrödinger equation, which is an essential part of quantum physics and therefore of quantum computing. This node is designed after an algorithm which translates a simulation of the Schrödinger equation into 2D space. It allows the user to visualize the behavior of a Gaussian wave packet according to the Schrödinger equation and makes it possible to add potential barriers and obstacles.

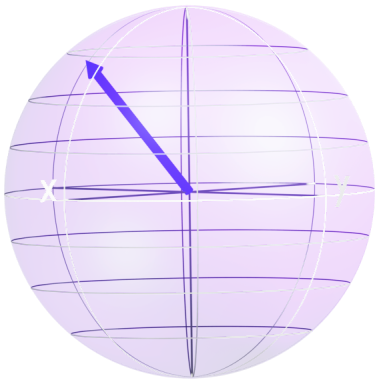

Figure 2: Bloch sphere made with Quantum Nodes

3 FUTURE WORK

In its current state, our tool computes quantum circuit results using Qiskit simulators. There is however the possibility to send these calculations to real qubits provided by IBM, a possibility that is not yet integrated in Quantum Nodes, but that could be in the future.

Since our add-on is open-source, it is intended to evolve thanks to artists, programmers and scientists.

In addition, our work allows a first integration of quantum computing in a 3D software, and opens the way to the use of this technology in 3D creation. 3D applications that involve time-consuming calculations could benefit from quantum computing, with the aim of drastically reducing the time and energy cost of these computations. This may benefit the following fields: animations, collisions, rendering, physical simulations, lights, destruction of objects, etc. Moreover, quantum computing could help the development of new tools highly desired by 3D artists for real-time simulations, and we hope that our work can inspire others to explore this path.

REFERENCES

Libby Heaney. 2019. Quantum computing and complexity in art. *Leonardo* 52, 3 (2019), 230–235.

Rolands Tiss. 2017. Creating motion graphics in Blender with Animation Nodes. (2017).

James R Wootton. 2020. Procedural generation using quantum computation. In *International Conference on the Foundations of Digital Games*. 1–8.